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(56) Documents Cited
GB 1584391 A GB 1202806 A US 4437356 A
US 4140026 A

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(54) **Gear elements having resilient teeth**

(57) A gear element 100 having resilient teeth is provided to reduce backlash and tooth noise, the resiliency being provided by a series of slots 101 extending inwardly from the base region between adjacent teeth. The slots may be filled with a resilient material (201 Fig 2 not shown). The gear element may take the form of a spur or pinion gear, a rack gear (Fig 3), an internal ring gear (Fig 4), a roller worm gear (Fig 5), a bevel gear (Fig 6), a worm wheel (Fig 7), or be one of a pair of inter-fitting coupling elements (Figs 8 and 9).

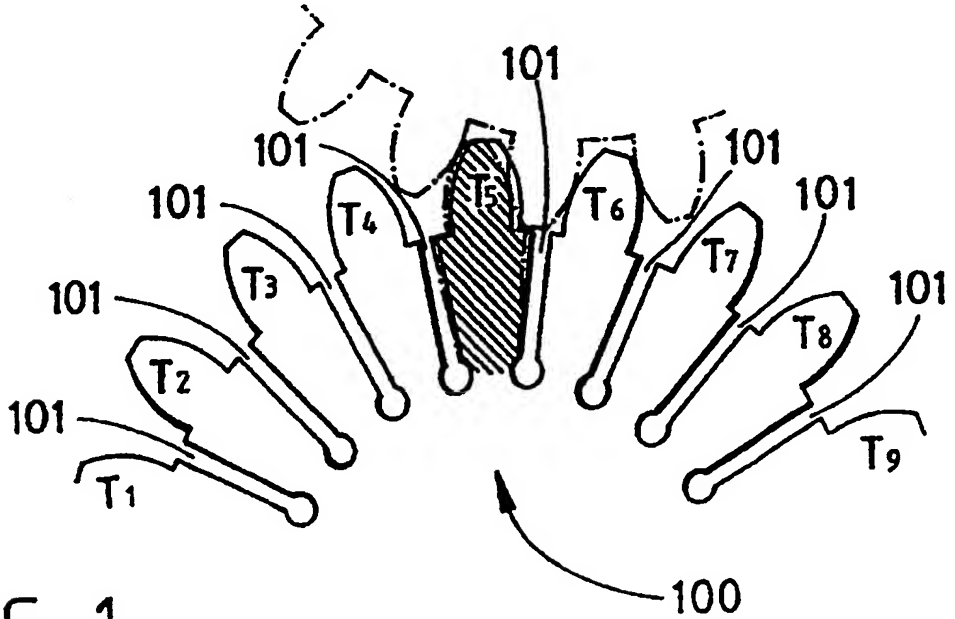

FIG. 1

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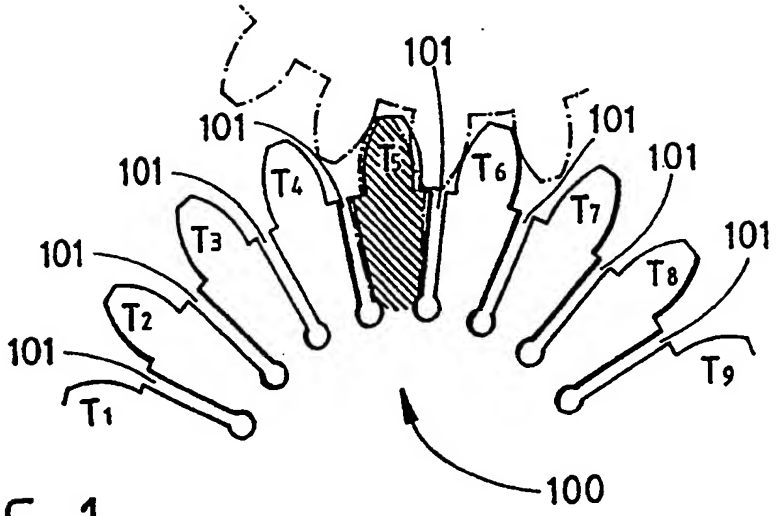

FIG. 1

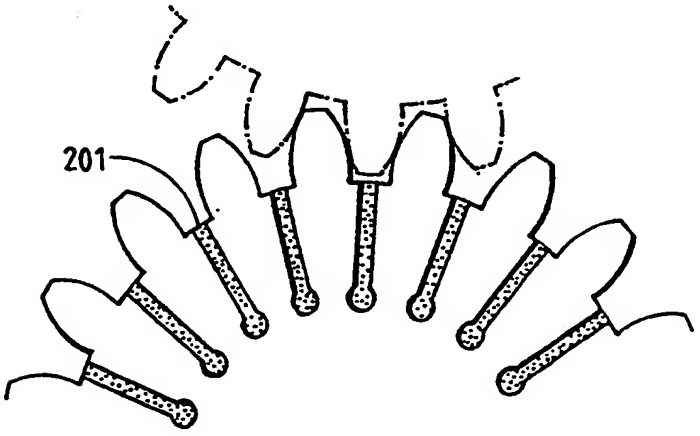

FIG. 2

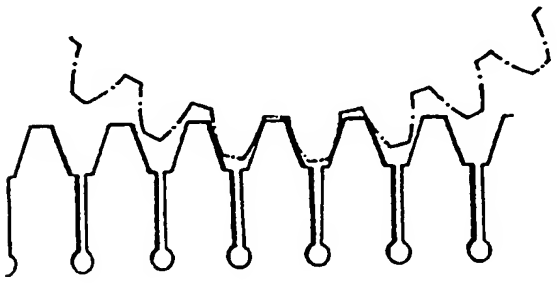

FIG. 3

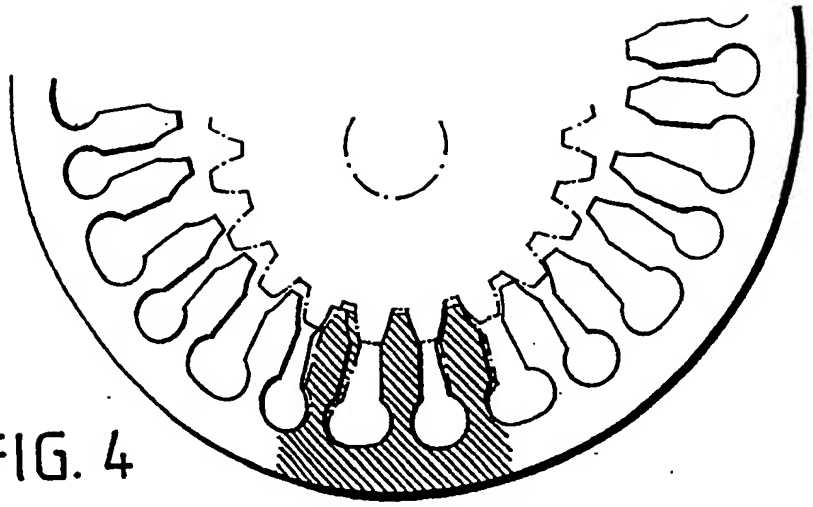

FIG. 4

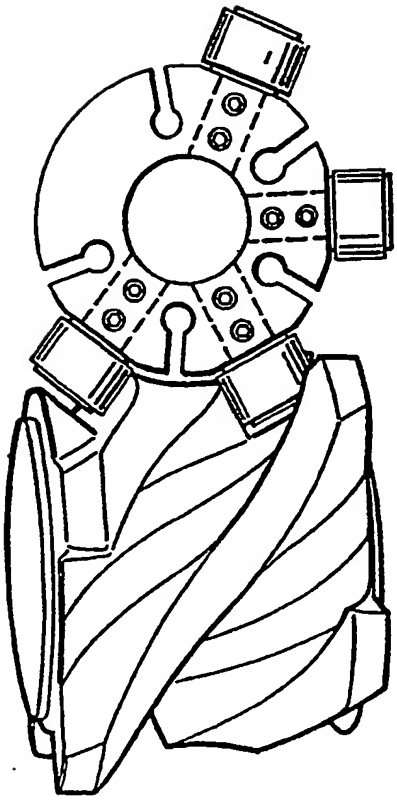

FIG. 5

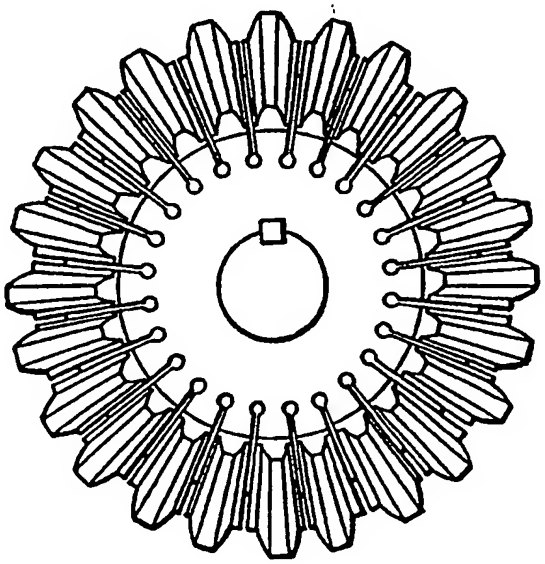

FIG. 6

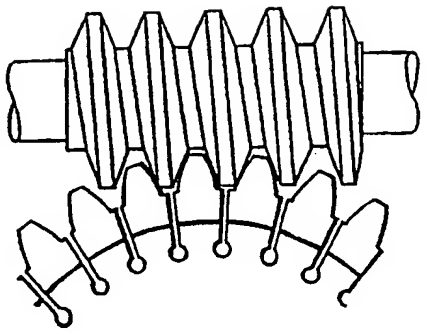

FIG. 7

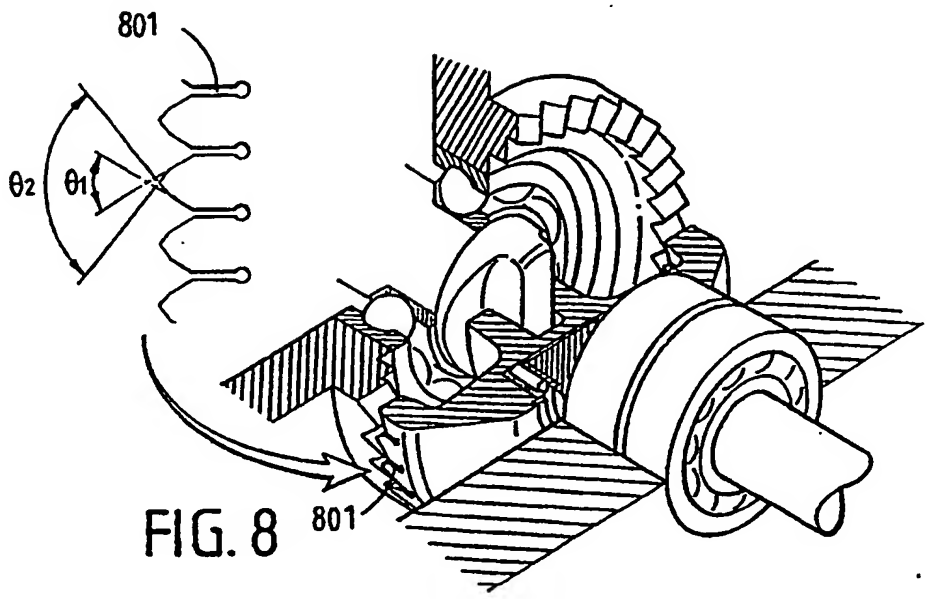

FIG. 8

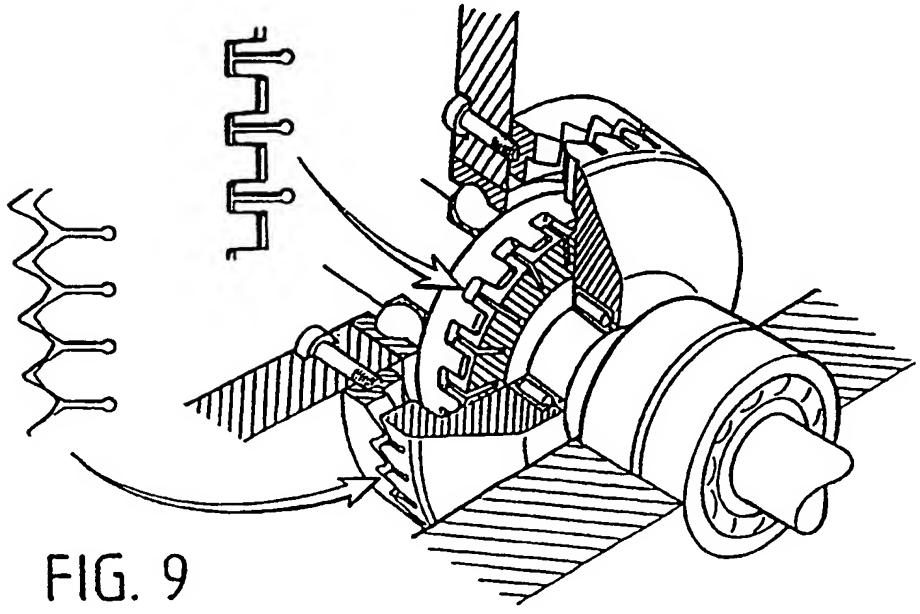

FIG. 9

TITLE

Flexible Back Lash Eliminating Design And Structure.

SUMMARY OF THE INVENTION

The conventional gear root often relates to rigid structure so that practical gear system must be added auxiliary structure but related back lash and noise still remain as a headache. The present flexible back lash eliminating design and structure is thus made in order to solve the aforesaid problem. more specifically transformation lash is made between roots of gear to enable each pitch to appear cross difference value. After made into gear set engagement, it will form a distribution greater than back lash and with bilateral cross flexible prestress for eliminating back lash during gearing; or further filling flexible stuff within transformation lash to minimize frictional noise. Because of gear roots with flexibility, the present invention is therefore suitable for medium-small power transfer while larger power may be obtained from increased tooth thickness or multiple gear sets arrangement.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagramatic view showing two gear sets to appear equi-pitch cross distribution and appear unequivalent phase difference distribution and with flexible gear root.

FIG. 2 is an embodiment showing shock-absorbing

soft metal or plastic flexible material is filled in the lash of transformation root of gear of FIG. 1.

FIG. 3 is an embodiment showing the present flexible back lash eliminating design and structure is applied to rack gear set.

FIG. 4 is an embodiment showing the present flexible back lash eliminating design and structure applied to internal gear set.

FIG. 5 is an embodiment showing the present flexible back lash eliminating design and structure applied to roller type worm gear set.

FIG. 6 is an embodiment showing the present flexible back lash eliminating design and structure applied to bevel gear set.

FIG. 7 is an embodiment showing the present flexible back lash eliminating design and structure applied to worm gear set.

FIG. 8 is an embodiment showing the present flexible back lash eliminating design and structure applied to axial harmonic gear.

FIG. 9 is an embodiment showing the present flexible back lash design and structure applied to axial harmonic gear set with toothes coupler.

DETAILED DESCRIPTION OF THE INVENTION

The present design relates to flexible back lash eliminating design and structure that form a distribution greater than back lash and with bilateral cross flexible prestress for eliminating back lash during gearing so as to minimize frictional

noise during gearing. which is characterized by:

two gear sets with equi-pitch cross distribution and unequivalent phase difference distribution, at least one gear set having flexible-root gear sets gearing, with distribution greater than back lash and with flexible tension.

The aforesaid structural principle is described below:

FIG. 1 is a diagramatic view showing two gear sets to appear equi-pitch cross distribution and appear unequivalent phase difference distribution and with flexible gear root, comprising gear set 100 peripherally distributed with odd numbers of teeth T1, T3, T5, T7...., even numbers of teeth T2, T4, T6, T8..... wherein pitch between each two odd teeth is 2P, each two even teeth is also 2P; pitch between each two odd teeth and even tooth as well as each two even teeth and odd teeth is unequivalent; both sides of each tooth root have transformation lash 101 cut in toward the center of circle to enable each tooth root with flexibility; upon engaging gear sets. the aforesaid specific pitch and flexible tooth root enables engaging teeth between gear sets to appear different-direction flexible back-lash free for the aforesaid odd-even teeth engaging and teeth engaging between two different gear sets whereby back lash is eliminate and frictional noise reduced during gearing.

FIG. 2 is an embodiment showing flexible material 201 is filled in the lash of transformation root of

gear teeth mainly for preventing noise caused by vibration during quick return of transformation teeth relatively disengaging.

Based on the principle shown in FIG. 1, we may apply it to right gear, bevel gear, rack gear set, worm gear set, internal gear, external gear, planet gear, harmonic gear, roller gear or toothed clutch.

FIG. 3 is an embodiment showing the present flexible back lash eliminating design and structure is applied to rack gear set, comprising:

1. connection of gear having flexible teeth and odd-even unequal phase difference with rigid rack;
2. connection of rigid odd-even unqual difference gear with flexible equi-pitch rack;
3. connection of flexible gear with rack of odd-even unequal phase difference.

FIG. 4 is an embodiment showing the present flexible back lash eliminating design and structure applied to internal gear set.

FIG. 5 is an embodiment showing the present flexible back lash eliminating design and structure applied to roller type worm gear set.

FIG. 6 is an embodiment showing the present flexible back lash eliminating design and structure applied to bevel gear set.

FIG. 7 is an embodiment showing the present flexible back lash eliminating design and structure applied to worm gear set.

FIG. 8 is an embodiment showing the present flexible back lash eliminating design and structure

applied to harmonic gear, wherein harmonic gear has produced differential displacement depending on different number of teeth between swinging bevel drive gear with driven gear because when the present flexible back lash eliminating design and structure is applied to swinging press-fit gears, not only with aforesaid transformation lash 801 at the tooth root but also with stuff, and further with relative press-fit by means of pre-tension after fitted or spring or fluid for packing two gears, and relative press-fit teeth in normal form but further greater angle 02 than tooth-form angle 01, i.e. 02>01 to compensate flexible transformed angle displacement during driving so as to guide relatively press-fit teeth point to avoid mutual interference.

FIG. 9 is an embodiment showing the present flexible back lash design and structure applied to harmonic gear set with tooth coupler wherein harmonic gear except with swinging bevel drive gear and driven gear as shown in FIG. 8, for producing differential displacement due to difference in the number of teeth between both, and differential displacement output is provided for rotary power transmission by means of teeth point with synco toothed coupler for guiding obtuse angle.

Except transformation lash between teeth, there is transformation lash between the teeth of synco toothed coupler, and toothed point is made in form of inverted obtuse angle or inverted arc against original tooth form, and packing pre-tension existing

after teeth engagement or spring pre-tension or fluid pre-tension available for eliminating back lash, and further filled in shock-absorbing soft metal or plastic flexible material to reduce noise. Referring to FIGs. 8 and 9, teeth relationship between gear set and synco clutch is arranged as odd-even unequal pitch, and further may appear equi-angle distribution while teeth point cut with guide-in bevel obtuse angle, and using spring or fluid as pre-tension packing for eliminating back lash after two teeth engagement; the aforesaid flexible back lash eliminating design and structure synco coupling clutch may be independently applied to other mechanism.

The present flexible back lash eliminating design and structure assembly may include:

1. Drive side with flexible and odd-even unequal pitch phase-difference drive gear engaging with rigid equal-pitch driven gear set at driven side;

2. Drive side with rigid and odd-even unequal pitch phase-difference drive gear engaging with flexible equal-pitch driven gear set;

3. Drive side with rigid and odd-even equal-pitch engaging with rigid odd-even unequal phase-difference driven gear set;

4. Drive side with rigid and odd-even equal-pitch engaging with flexible odd-even unequal phase-difference driven gear set.

5. Both drive and driven sides with flexible odd-even unequal-pitch gear sets.

Referring to the applications in FIG. 1 thru FIG. 9, flexible lash of various gear sets may further be filled soft metal or plastic material as stuff for absorbing noise, and such stuff may include which for flexible lash of equal-pitch gears.

CLAIMS:

1. A flexible back lash eliminating design and structure relates to transformation lash is made between roots of gear to enable each pitch to appear cross difference value, after made into gear set engagement, it will form a distribution greater than back lash and with bilateral cross flexible prestress for eliminating back lash during gearing; or further filling flexible stuff within transformation lash to minimize frictional noise, comprising gear set 100 peripherally distributed with odd numbers of teeth T1, T3, T5, T7....., even numbers of teeth T2, T4, T6, T8..... wherein pitch between each two odd teeth is 2P, each two even teeth is also 2P; pitch between each two odd teeth and even tooth as well as each two even teeth and odd teeth is unequivalent; both sides of each tooth root have transformation lash 101 cut in toward the center of circle to enable each tooth root with flexibility; upon engaging gear sets. the aforesaid specific pitch and flexible tooth root enables engaging teeth between gear sets to appear different-direction flexible back-lash free for the aforesaid odd-even teeth engaging and teeth engaging between two different gear sets whereby back lash is eliminate and frictional noise reduced during gearing.

2. The flexible back lash eliminating design and structure according to claim 1, including application to right gear, bevel gear, rack gear set, worm gear

set, internal gear, external gear, planet gear, harmonic gear, roller gear or toothed clutch, including:

1. Drive side with flexible and odd-even unequal pitch phase-difference drive gear engaging with rigid equal-pitch driven gear set at driven side;

2. Drive side with rigid and odd-even unequal pitch phase-difference drive gear engaging with flexible equal-pitch driven gear set;

3. Drive side with rigid and odd-even equal-pitch engaging with rigid odd-even unequal phase-difference driven gear set;

4. Drive side with rigid and odd-even equal-pitch engaging with flexible odd-even unequal phase-difference driven gear set.

5. Both drive and driven sides with flexible odd-even unequal-pitch gear sets.

3. The flexible back lash eliminating design and structure according to claim 1, which is applied to rack gear set, comprising:

1. connection of gear having flexible teeth and odd-even unequal phase difference with rigid rack;

2. connection of rigid odd-even unqual difference gear with flexible equi-pitch rack;

3. connection of flexible gear with rack of odd-even unequal phase difference.

4. The flexible back lash eliminating design and structure according to claim 1, which is applied to

harmonic gear, wherein harmonic gear has produced differential displacement depending on different number of teeth between swinging bevel drive gear with driven gear because when the present flexible back lash eliminating design and structure is applied to swinging press-fit gears, not only with aforesaid transformation lash 801 at the tooth root but also with stuff, and further with relative press-fit by means of pre-tension after fitted or spring or fluid for packing two gears, and relative press-fit teeth in normal form but further greater angle 02 than tooth-form angle 01, i.e. 02>01 to compensate flexible transformed angle displacement during driving so as to guide relatively press-fit teeth point to avoid mutual interference.

5. The flexible back lash eliminating design and structure according to claim 1, which is applied to harmonic gear set with tooth coupler wherein harmonic gear except with swinging bevel drive gear and driven gear for producing differential displacement due to difference in the number of teeth between both, and differential displacement output is provided for rotary power transmission by means of teeth point with synco toothed coupler for guiding obtuse angle, except transformation lash between teeth, there is transformation lash between the teeth of synco toothed coupler, and toothed point is made in form of inverted obtuse angle or inverted arc against original tooth form, and packing pre-tension existing

after teeth engagement or spring pre-tension or fluid pre-tension available for eliminating back lash.

6. The flexible back lash eliminating design and structure according to claim 1, teeth relationship between gear set and synco clutch is arranged as odd-even unequal pitch, and further may appear equi-angle distribution while teeth point cut with guide-in bevel obtuse angle, and using spring or fluid as pre-tension packing for eliminating back lash after two teeth engagement.

7. The flexible back lash eliminating design and structure according to claim 1 or 2 or 3 or 4 or 5 or 6, flexible lash of various gear sets may further be filled soft metal or plastic material as stuff for absorbing noise, and such stuff may include which for flexible lash of equal-pitch gears.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (12) (The Search report)	Application number GB 9402496.5
Relevant Technical Fields (i) UK Cl (Ed.M) F2Q (ii) Int Cl (Ed.5) F16H	Search Examiner A HABBIJAM Date of completion of Search 30 MARCH 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1-7

Categories of documents

X:	Document indicating lack of novelty or of inventive step.	P:	Document published on or after the declared priority date but before the filing date of the present application.
Y:	Document indicating lack of inventive step if combined with one or more other documents of the same category.	E:	Patent document published on or after, but with priority date earlier than, the filing date of the present application.
A:	Document indicating technological background and/or state of the art.	&:	Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 1584391	(MIKIHARU IMAZAIKE) see in particular Figures 4 and 5	1, 2
X	GB 1202806	(GEMCO ELECTRIC CO) see in particular Figures 2, 3 and 6	1, 2
X	US 4437356	(MIKIHARU IMAZAIKE) see clearances 6 between teeth 2, 3; Figures 1-4	1, 2
X	US 4140026	(ROUVEROL) see gashes 17 in Figure 1	1, 2

Databases:The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).